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(54) Improvements in or relating to airships

(57) An airship is provided with a plurality of buoyancy cells 6, 7 and 8. The cells are provided with damage control ballonets 9, 10 which are inflatable to fill the cells to repair any damage which would otherwise result in structural collapse of the airship. Some of the cells have a dual purpose function in which the ballonets may be used to adjust the trim of the airship. A gondola 15 is supported beneath the airship by a load curtain 4, 5, 14 which also serves to provide lateral cell partitions. The airship has improved damage tolerance and is suited to a surveillance roll in a hostile environment such as providing a radar lookout post.

FIG. 4.

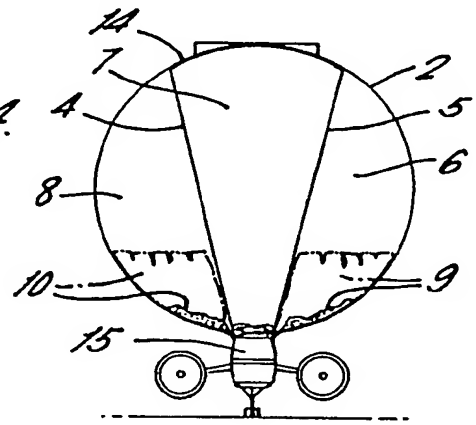

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FIG. 1.

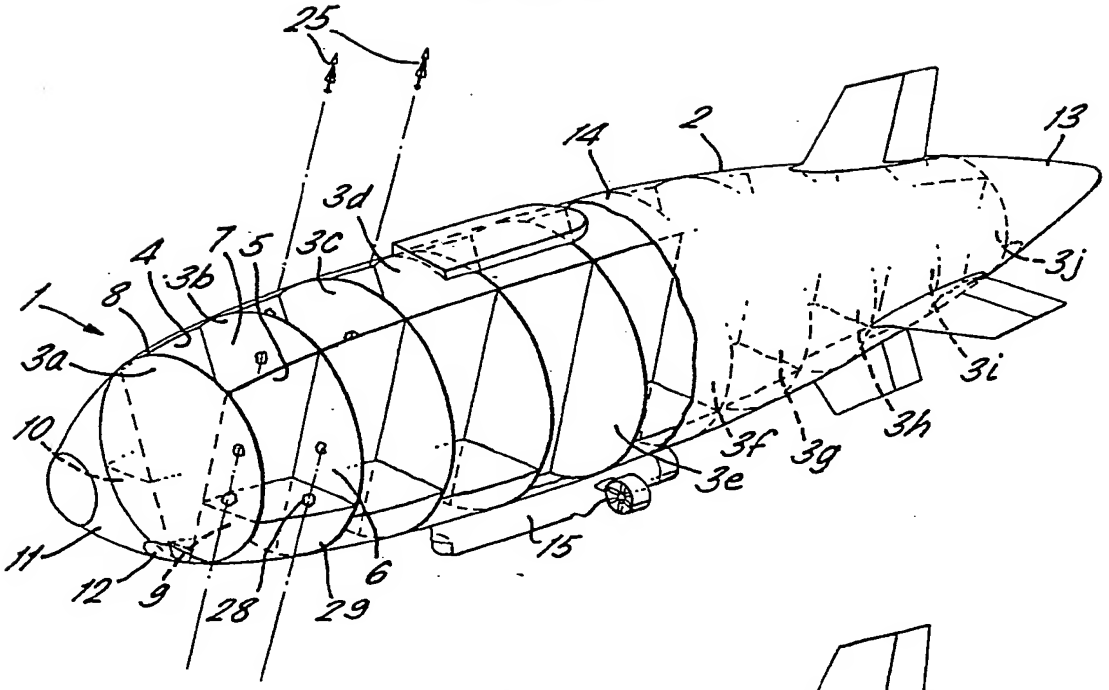
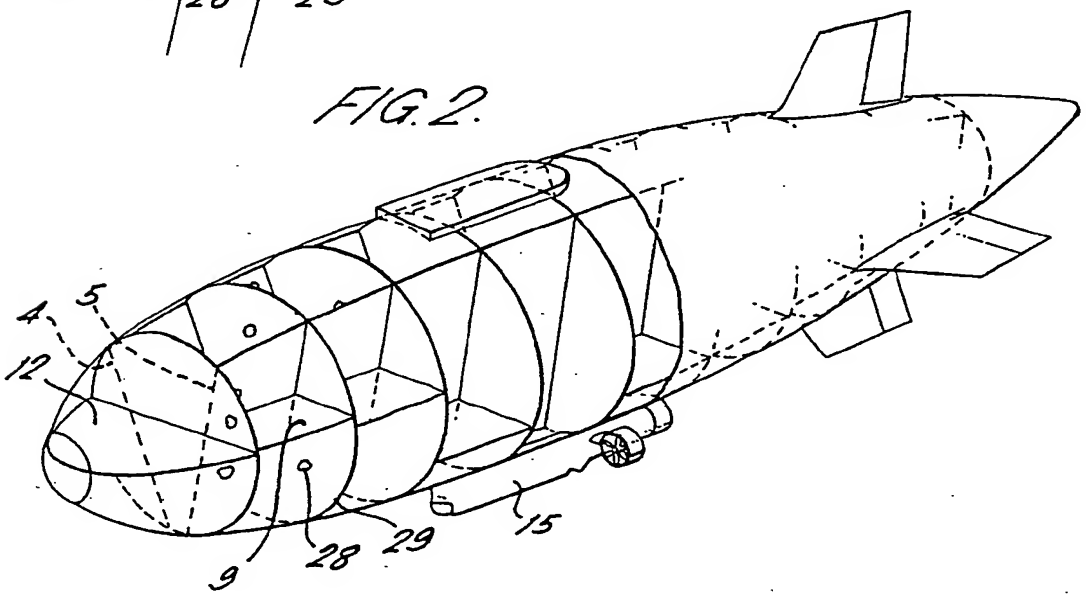


FIG. 2.



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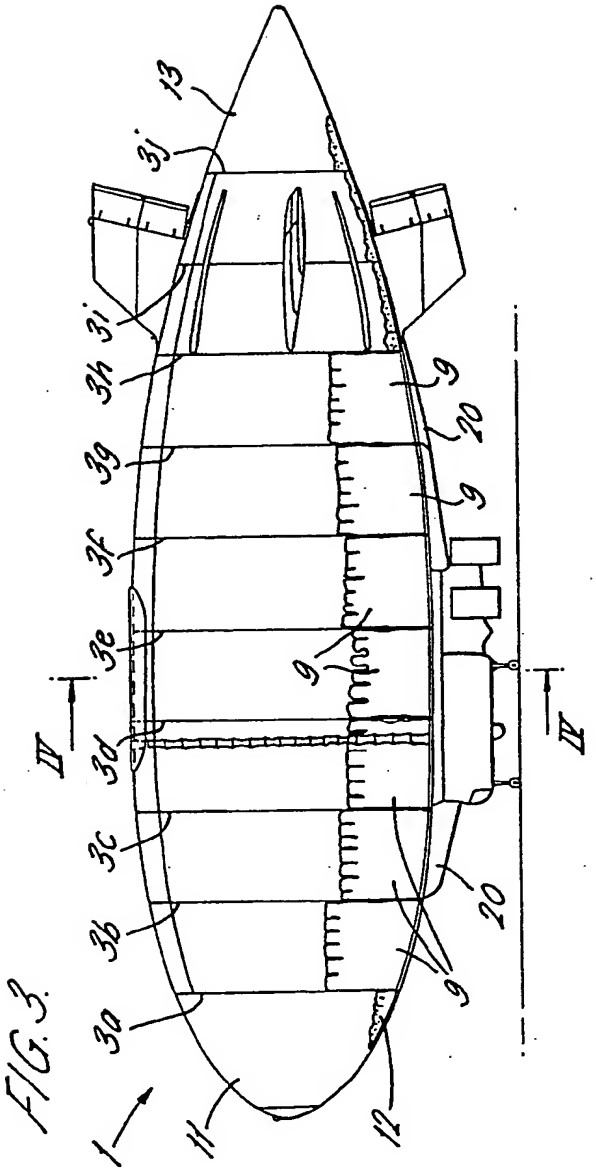

FIG. 3.

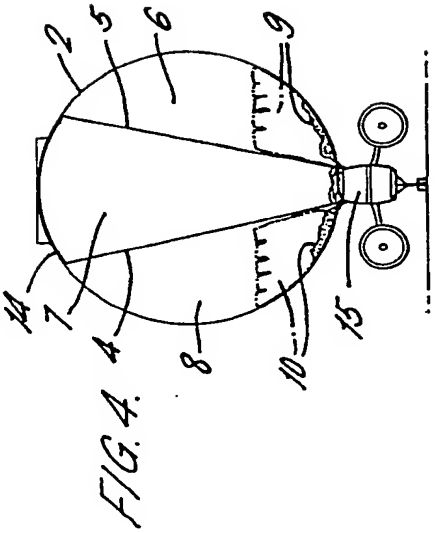

FIG. 4.

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FIG. 5.

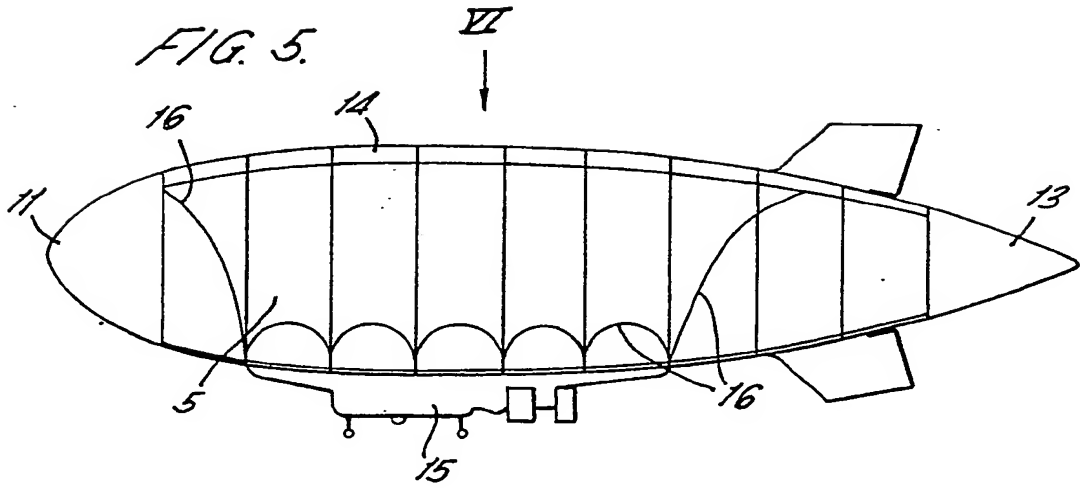
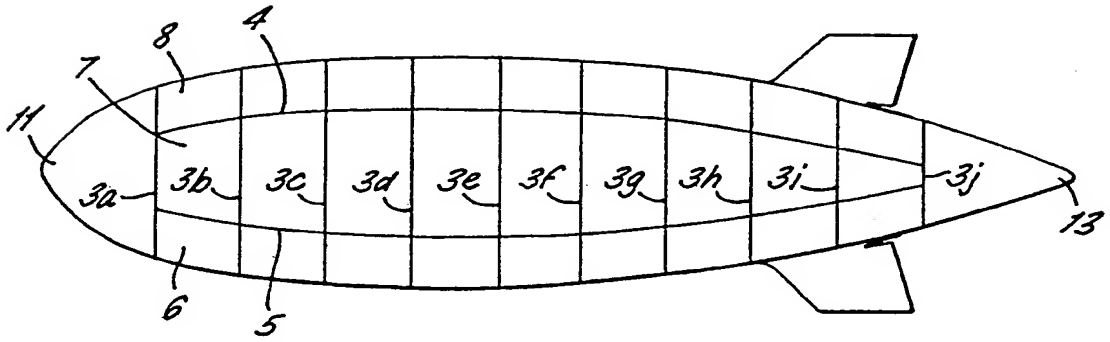


FIG. 6.



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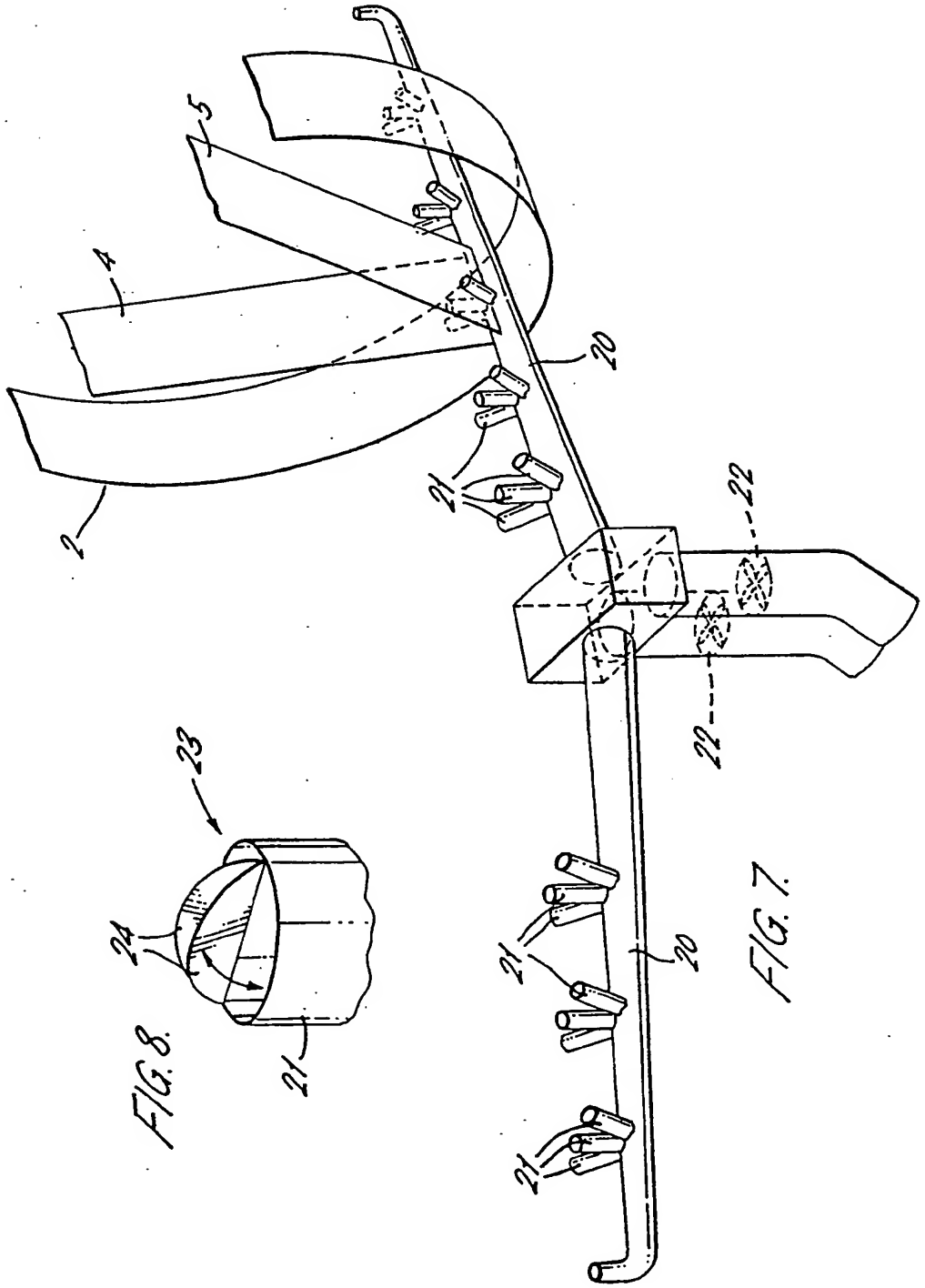

FIG. 8.

FIG. 7.

SPECIFICATION

Improvements in or relating to airships

This invention relates to airships and in particular but not exclusively to a non rigid airship have a plurality of buoyancy cells. More particularly the invention is concerned with the vulnerability of such airships to attack by missiles and the like.

It is known for rigid and non rigid airships to have a buoyancy compartment divided into a number of cells each containing a lighter than air gas such as helium which is generally maintained at a pressure exceeding the ambient atmospheric pressure in order to impart a degree of structural rigidity to the airship.

A problem with such airships is that in the event of the wall of a cell being damaged by a missile for example such that the lighter than air gas is able to escape the resultant loss in pressure within that cell will adversely affect the structural integrity of the airship.

This is particularly a problem for non rigid airships for which damage to the cell wall resulting in loss of pressure will have an even more pronounced affect on the structural integrity of the airship since the envelope shape is maintained by tension derived from the contained gas pressure.

In addition to structural damage a loss of buoyancy will result in both cases as the escaping lighter than air gas is replaced by air.

According to the present invention there is disclosed an airship having a plurality of buoyancy cells, at least some of which cells have damage control means whereby a damage hole may be partially or completely sealed, the damage control means of a cell comprising an inflatable ballonet which in use is inflated so as to obturate the hole.

Preferably a damage control ballonet may be inflated to fill a damaged cell. This is advantageous when damage is incurred at the top of a cell with total loss of the lighter than air gas.

Preferably a damage control ballonet whilst deflated is located in a lower portion of a cell and extends progressively upwardly during inflation in sealing contact with progressively higher portions of the cell well. An advantage of such an arrangement is that where a damage hole is located intermediate the top and bottom of a cell wall the ballonet need be inflated only to the extent that sealing contact is achieved to a height which exceeds the hole location so that an upper portion of the cell remains unoccupied by the ballonet and continues to provide buoyancy by virtue of the remaining volume of lighter than air gas. Once the hole is sealed, some continued inflation of the ballonet will be required to compress the remaining cell space in order to pressurise the remaining gas.

Advantageously the damage control means includes pressure sensor means for sensing the pressure within a cell and inflation control means for initiating ballonet inflation in response to a pressure drop consequent to cell damage.

Advantageously the control means ceases inflation once cell pressure is restored to a predetermined level.

Advantageously the control means includes a oneway valve selectively communicating from an air supply duct to the ballonet and actuated by the difference between the air pressure within the duct and that within the ballonet.

Conveniently the valve is a flap valve.

In a preferred embodiment the airship is of non rigid construction and has a plurality of contiguous cells. Advantageously such a non rigid airship has an elongate envelope containing a buoyancy compartment divided into cells by longitudinally spaced bulkheads.

Conveniently an upper surface of the buoyancy compartment supports a load curtain in contact therewith, which load curtain includes two side portions entending longitudinally and generally downwardly through the compartment for attachment to an underslung load and thereby dividing the space between at least some pairs of adjacent bulkheads into three laterally contiguous cells.

Conveniently each ballonet is inflatable by air ducted from a common source via a longitudinally extending main duct.

Conveniently the airship includes trim control means comprising means for inflating and deflating one or more of the damage control ballonets to adjust the trim of the airship. Such trim adjustment may for example be necessary following the repair by ballonet inflation of a damaged cell resulting in a shift of the net buoyancy force with respect to the centre of gravity. The trim control means may also replace the conventional trim controlling apparatus for adjusting trim in normal flight.

Preferably those dual purpose ballonets comprising both trim control means and damage control means are adapted to withstand repeated inflation and deflation in use whereas those single purpose ballonets comprising only damage control means are of relatively lightweight material adapted to withstand relatively fewer inflations and deflations.

It is therefore possible to use lightweight material in making the single purpose ballonets which serve for emergency use only with consequent savings in weight and cost.

Advantageously the middle cell of each group of three laterally contiguous cells includes a single purpose damage control ballonet. The laterally adjacent dual purpose ballonets may then be used for lateral trimming of the airship whilst the central cell ballonet is reserved for emergency use.

Particular embodiments of the invention will now be described by way of example only

with reference to the accompanying drawings of which

Figure 1 is a perspective part cut away view of a multi-cellular non rigid airship showing cell damage resulting from the passage of two missiles,

Figure 2 shows a similar view of the airship of Fig. 1 after deployment of damage control means,

Figure 3 is a longitudinally sectioned view of the airship of Figs. 1 and 2, whilst undamaged and grounded,

Figure 4 is a transversely sectioned view of the airship of Fig. 3 in the direction of arrow IV showing port and starboard cell ballonets both deflated and partially inflated (shown in solid and broken lines respectively),

Figure 5 is a side view of the airship of Figs. 3 and 4 showing detail of a load curtain,

Figure 6 is a plan view of the airship of Fig. 5,

Figure 7 is a perspective view of an air duct for use in the airship of Figs. 1 to 6, and

Figure 8 is a valve for use with the air duct of Fig. 7.

The airship (1) of Figs. 1 and 2 has an elongate envelope (2) comprising a buoyancy compartment which is compartmented by ten longitudinally spaced bulkheads (3a–3j). The bulkheads are of fabric construction so as to be non rigid.

Between each pair of adjacent bulkheads a further threefold divisions is effected by two downwardly extending portions (4, 5) of a load curtain. So that for example between the foremost bulkheads (3a, 3b) three cells are formed comprising a port cell (6), middle cell (7) and starboard cell (8). The envelope is thereby divided into 29 cells each of which is filled with helium to a pressure greater than that of the ambient air.

The port and starboard cells (6, 8) include dual purpose ballonets (9, 10) which rest at the bottom of their respective cells when deflated. These dual purpose ballonets (9, 10) may be used as damage control means by inflation to partially fill or fill their respective cells or may be partially inflated (as shown) when used as trim control means.

A nose cell (11) is formed forward of the foremost bulkhead (3a) and includes a single purpose ballonet (12) of relatively lightweight construction for emergency damage control use. An additional single purpose ballonet (not shown) is provided in a tail cell (13) formed rearward of the rearmost bulkhead (3j) and similar ballonets are provided in each of the middle interbulkhead cells (e.g. 7). Those port and starboard cells within the two pairs of bulkheads (3h–3i, 3i–3j) adjacent the tail cell (13) also include single purpose ballonets, the remaining port and starboard cell being provided with dual purpose ballonets.

In Fig. 3 the grounded airship (1) is shown with trim control means deployed to provide negative buoyancy by partial inflation of the dual purpose ballonets of which the port side dual purpose ballonets (9) are visible in the drawing.

As shown in Fig. 4 the single purpose middle cell ballonet remains deflated. The partially inflated dual purpose ballonets (9, 10) are here shown in broken lines for comparison with their deflated position shown in solid lines.

The load curtain (4, 5, 14) as shown in Figs. 5 and 6 is a fabric sheet reinforced with tapes (16) and extends over an upper portion (14) of the envelope (2). The curtain is connected to an underslung load comprising a gondola (15) by means of the downwardly extending portions (4, 5) which also serve as later 1 cell partitions as described above.

Figure shows an air duct (20) having branches (21) each being connected to the ballonet of a respective cell. The air duct communicates compressed air from a turbine (22). A flap valve (23) is shown in Fig. 8 in enlarged perspective view in which the arrow indicates the possible motion of a flap (24).

Damage caused by the passage of two missiles (25) through the airship is shown in Fig. 1.

When a damage hole occurs the pressure within a cell drops as the helium escapes. A sensor (not shown) detects this change in pressure and a valve is actuated via a control means (not shown) to admit air to the appropriate ballonet. The ballonet is inflated until the hole is sealed and then further inflated until the cell pressure reaches a predetermined level which is sufficient to retain the structural integrity of the cell and hence that of the airship.

In Figs. 1 and 2 both the nose cell (11) and the foremost inter-bulkhead port cell (6) have sustained damage holes (28) in the outer cell wall (29). In response to this the respective ballonets are inflated as shown in Fig. 2 to obturate the holes and repressurise the remaining helium. In the case of the nose cell (11) the ballonet was previously uninflated as seen in Fig. 1 being a single purpose damage control ballonet whilst the inter-bulkhead port cell (6) was previously partially inflated as part of the trim control of the airship.

Where a damage hole occurs in a lower portion of a cell wall the hole may be sealed with relatively little loss of helium so that a degree of buoyancy is retained in that cell. If however the damage hole occurs at the top of the cell it will be necessary to fill the cell completely with the ballonet with consequent total loss of buoyancy in that cell. In this latter situation however the inflated ballonet performs the essential role of enabling the cell to function as a structural unit of the airship. Further action might in either case be required to retrim the airship by inflating appropriate ballonets or to compensate for lost buoyancy us-

ing vectored thrust or by load reduction.

Airships in accordance with the present invention may advantageously be used in military applications where minimum vulnerability to envelope penetration is advantageous. Such an airship has improved damage tolerance over known airships and is therefore ideally suited to a surveillance role in a hostile environment such as e.g. in naval applications as a radar lookout post accompanying a fleet.

CLAIMS

1. An airship having a plurality of buoyancy cells, at least some of which cells have damage control means whereby a damage hole may be partially or completely sealed, the damage control means of a cell comprising an inflatable ballonet which in use is inflated so as to obturate the hole.

2. An airship as claimed in Claim 1 wherein a damage control ballonet may be inflated to fill a damaged cell.

3. An airship as claimed in any preceding claim wherein a damage control ballonet whilst deflated is located in a lower portion of a cell and extends progressively upwardly during inflation in sealing contact with progressively higher portions of the cell wall.

4. An airship as claimed in any preceding claim wherein the damage control means includes pressure sensor means for sensing the pressure within a cell and inflation control means for initiating ballonet inflation in response to a pressure drop consequent to cell damage.

5. An airship as claimed in Claim 4 wherein the control means ceases inflation once cell pressure is restored to a predetermined level.

6. An airship as claimed in either of Claims 4 and 5 wherein the control means includes a oneway valve selectively communicating from air supply duct to the ballonet and actuated by the difference between the air pressure within the duct and that within the ballonet.

7. An airship as claimed in Claim 7 wherein the valve is a flap valve.

8. An airship as claimed in any preceding claim of non rigid construction and having a plurality of contiguous cells.

9. An airship as claimed in Claim 8 having an elongate envelope containing a buoyancy compartment divided into cells by longitudinally spaced bulkheads.

10. An airship as claimed in Claim 9 wherein an upper surface of the buoyancy compartment supports a load curtain in contact therewith, which load curtain includes two side portions extending longitudinally and generally downwardly through the compartment for attachment to an underslung load and thereby dividing the space between at least some pairs of adjacent bulkheads into three laterally contiguous cells.

11. An airship as claimed in any preceding claim wherein each ballonet is inflatable is by air ducted from a common source via a longitudinally extending main duct.

12. An airship as claimed in any preceding claim including trim control means comprising means for inflating and deflating one or more of the damage control ballonets to adjust the trim of the airship.

13. An airship as claimed in Claim 12 wherein those dual purpose ballonets comprising both trim control means and damage control means are adapted to withstand repeated inflation and deflation in use whereas those single purpose ballonets comprising only damage control means are of relatively lightweight material adapted to withstand relatively fewer inflations and deflations.

14. An airship as claimed in Claim 13 as dependent on Claim 10 wherein the middle cell of each group of three laterally contiguous cells includes a single purpose damage control ballonet.

15. An airship substantially as hereinbefore described and as shown in the accompanying drawings.

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